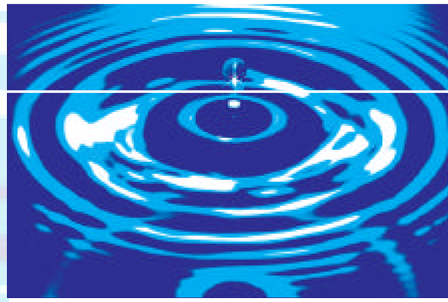

Water Quality Monitoring Strategy for the Otay River Watershed

February 2005

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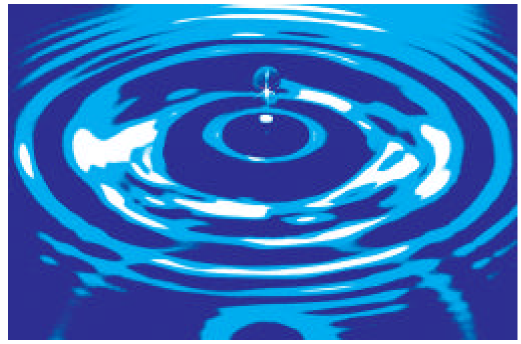

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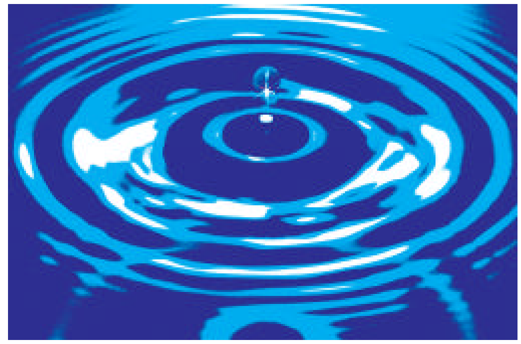

1 INTRODUCTION

The goal of this watershed planning effort is to develop and implement a watershed-wide aquatic resource management plan and implementation program, which will include preservation, enhancement, and restoration of aquatic resources, while allowing reasonable and responsible economic development and activities within the watershed-wide study area.

Pressures on the environmental quality of the Otay River watershed are expected to increase with urbanization. As with much of southern California, the Otay River watershed is a rapidly urbanizing coastal watershed, with development concentrated in the flatter coastal plain and less dense urbanization in the higher, inland elevations. The population in this watershed is expected to nearly double in the next 25 years, which will contribute to loss of open space and recreational land (40%) and put additional strain on an ecosystem that is already under a variety of urban threats.

To ensure that beneficial uses in the Otay River system continue to be supported, it is important to establish baseline water quality conditions and document any changes in conditions that may occur in the future. Therefore, a long-term monitoring program for the watersheds and reservoirs to establish baseline conditions, identify trends in degradation, isolate sources of contamination, and determine effects of management practices must be established.

Degradation of water quality may already be occurring. Figure 1 summarizes the relative water quality integrity of riparian reaches on the Otay River watershed. Smith (2004) evaluated the Otay River watershed by calculating a Water Quality Index for 212 riparian reaches with the Otay River system. The Water Quality Index is a measure of existing pollutant loading (including nutrients, pesticides, hydrocarbons, and sediment) relative to the historical pollutant loadings from culturally-unmodified watersheds in the region. Because of a scarcity of data, the Water Quality Index for the Otay River watershed was determined based on the relative change in watershed characteristics that influence water quality integrity. The Water Quality Index analysis considered 20 watershed characteristics, covering three general categories: (1) change in land use on the overall watershed and local drainages; (2) change in stream channels on the watershed; and changes to the connection between the watershed and conveyance (e.g., sediment regime, floodplain, and the condition of riparian vegetation).

Recommendations contained in "Baseline Water Quality Indicators for the Otay Watershed" (Aspen 2004) are the basis for the strategy outlined in this document. The establishment of a monitoring program is an important and cost-effective action for several reasons, which stem from the likelihood that future development can negatively affect the various watercourses addressed in this program. First, and most important, the trends evidenced in monitoring data can provide an early indication of degradation in water quality or channel characteristics. This will enable corrective actions to be implemented before catastrophic impacts are evidenced, at a considerable savings over what would be required in belated remediation and recovery projects. Additionally, a monitoring program implemented well in advance of developments in the watershed allows the establishment of baseline conditions in the watercourses, allowing a quantitative evaluation of future impacts. This in turn will permit determining the efficacy of corrective actions, should these become necessary.

From a scientific viewpoint, the water quality and stream channel characteristics of these watercourses undergo time and space variations on a range of scales, a fact which complicates the problem of isolating the specific impacts on a watercourse from development. The longer duration for which a data base can be assembled, including both the proposed monitoring as well as historical data, the more reliable can development effects be separated from natural hydroclimatological variability. The more reliably that specific development impacts can be quantified in general, the more specific, and therefore cost-effective, the necessary corrective actions be delineated.

The implementation of a monitoring program can adopt several strategies that substantially improve the reliability and scientific value of the data with relatively small incremental cost in execution. One of these strategies is to recognize and exploit the economies of scale. In monitoring, an initial investment must be made in equipment and manpower. This investment is a threshold expense (fielding a sampling crew, for example) above which increases in scope such as occupying more stations, profiling with field probes, or analyzing additional variables incur minor (or perhaps zero) additional expense, yet greatly enhance the value of the data. Another strategy is timely data entry and review of data by competent scientists, including analysis and plots of trends, spatial variations, and dependencies among variables. Not only does this provide provisional information about what the data disclose, more importantly this allows the identification of aberrant or erroneous data quickly enough that the original measurements can be scrutinized or perhaps repeated.

Due to the large geographic area covered by the project watershed, inherent variability of the system, and differential nature of historical impacts to the watershed, the selection of appropriate locations and constituents for monitoring is critical. These locations may include the reservoirs, local drainage, main stem channel, main stem tributary channels, and drainage basin. The local drainage includes the area from which surface water drains directly to the main stem channel, or tributaries that enter the main stem channel. The main stem channel is the primary channel in the local drainage, and main stem tributaries are stream channels that originate in the local drainage of the riparian reach and flow directly to the main stem channel.

At each of the locations considered for monitoring, specific constituents must be selected for monitoring that are associated with changes in land use and beneficial uses of the water body. Assessing changes in the range of loading in each pollutant category can be determined directly by comparing data on current loading with data on historical loading when such data are available. While there is some historical and recent monitoring data available for a limited number of stations in the Otay River watershed, little or no data are available at the larger scale.

An important additional feature to consider is the hydrology, particularly the perennialization of stream flow. Perennialization refers to the conversion of intermittent or ephemeral stream channels to a perennial stream through the addition of surface water flow (usually at low levels) in a stream channel from artificial supplies of surface water and shallow groundwater aquifers. The source of water usually occurs in the form of irrigation or treated return water. In arid and semi-arid regions, perennialization facilitates a shift in plant and animal community composition away from what normally occurs in a channel that is not perennialized. Perennialization also has the potential to affect physical and chemical processes in riparian ecosystems. Figure 2 indicates that changes in hydrology may already affect many reaches in the watershed.

Conventional water quality monitoring is very problematic on a system with so little flow, especially in the lower reaches of the system and may be of limited value because of the lack of historical data with which to compare newly acquired data. Consequently, a substantial focus of the monitoring strategy deals with characterization of the hydrology and channel morphology of the system. This is a particularly important element in the sub-basins expected to experience the most urbanization.

The Otay River watershed has three distinct areas for which individual monitoring strategies are required. These three include the Upper Watersheds, Upper and Lower Otay Reservoirs, and the Lower Watersheds. The strategies for each of these will be considered separately.

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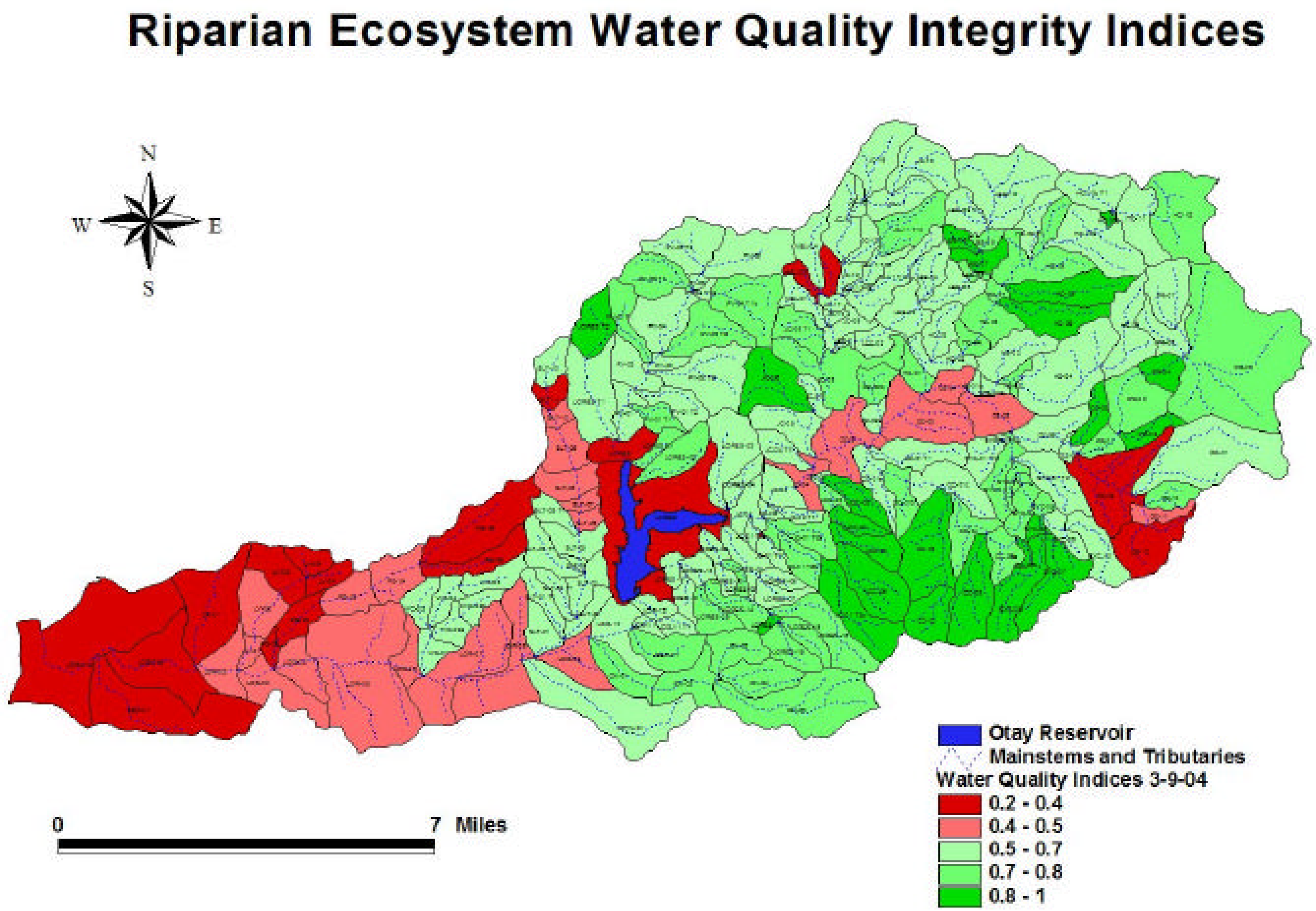

Figure 1 Water Quality Integrity Indices for Riparian Reaches Extrapolated to Local Drainages (Smith, 2004)

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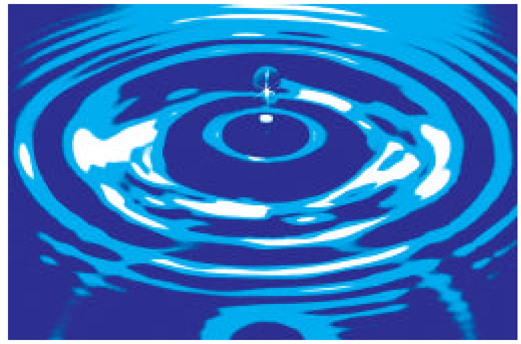

2 UPPER WATERSHED MONITORING AT JAMUL CREEK

Upper Watershed Strategy: *Ambient and wet-weather monitoring plan to document baseline conditions and trends with an emphasis on potential changes associated with the widespread use of septic systems in the watershed.*

The Upper Watersheds are only sparsely developed in most areas and are unlikely to experience significant urbanization in the near future. Nevertheless, environmental impacts may be caused by recreational uses and vacation/second homes constructed along and near the area creeks. These creeks include: Jamul Creek, Dulzura Creek, Hollenbeck Canyon Creek and Proctor Valley Creek. Potential environmental impacts in the Upper Watersheds also have the potential to degrade water quality in the Upper and Lower Otay Reservoirs, which are important for recreation and water supply.

The Upper Watershed is vital to the public health of the surrounding areas because it contributes to the water supply of the area. A key facet of the overall monitoring strategy must be to gather data to assist in the preservation of the designated municipal water supply use (MUN). The major threats to the integrity of the Upper Otay are non-point source input of nutrients and pathogens, failed septic systems, and nutrient and pathogen loading from waterfowl and other wildlife. The soils in the Upper Otay catchment are also of very poor quality and are characterized as severely erodible.

The water quality monitoring strategy for the Upper Watersheds includes routine bioassessment, characterization of stormwater runoff, and evaluation of changes in the quality of dry weather flows. The priority of the monitoring strategy is to determine whether beneficial uses are being maintained. Current and potential uses mainly include:

- Recreation (REC1, REC2)
- Water supply (MUN, IND, PROC, AGR)
- Habitat (WARM, WILD)

These beneficial use designations are defined as:

REC1 - Contact Water Recreation. Includes uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and SCUBA diving, surfing, white water activities, fishing, or use of natural hot springs.

REC2 - Non-Contact Water Recreation. Includes the uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

MUN - Municipal and Domestic Supply. Includes uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

PROC - Industrial Process Supply. Includes uses of water for industrial activities that depend primarily on water quality.

IND - Industrial Service Supply. Includes uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

AGR - Agricultural Supply. Includes uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

WARM - Warm Freshwater Habitat. Includes uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates.

WILD - Wildlife Habitat. Includes uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

The USGS currently operates the Jamul Creek Gauging Station (USGS 11014000) above the reservoir. Water quality monitoring (wet and dry weather) should be conducted at this site so that flow-weighted samples can be collected and annual loads determined for selected constituents. Wet weather monitoring should occur in at least four events per year to develop a sufficient number of samples for statistical analysis.

2.1 Recreation

Recreational activities are one of the main beneficial uses in the Upper Watersheds of the Otay River. The primary water quality concern is increases in bacteria concentrations in dry weather flows may affect designated REC1 and REC2 beneficial uses and further contribute to the impairments already identified in San Diego Bay. Consequently, monitoring should include:

- fecal coliform
- total coliform
- enterococci

These various indicator organisms were chosen to provide a comparison with historical data from this area and to assess compliance with objectives that are now being adopted for beaches and waterways in the San Diego area.

A potential source of pathogenic and indicator organisms is septic tanks that are not functioning properly. There are several potential causes of discharge of bacteria and viruses from septic systems. Excessively sandy soil may not provide sufficient filtering of the discharge and allow the partially filtered effluent to enter the creeks as baseflow. On the other hand, soils with high clay content may not be sufficiently permeable and may result in the effluent appearing on the ground surface especially during extended wet periods. The effluent may then be washed into adjacent waterways during storm events. Finally, drainfields may clog or may be undersized for current water use, which also results in effluent on the surface.

Bacteria concentrations are commonly high in stormwater runoff, even in relatively undeveloped watersheds. Consequently, it is important to also characterize bacteria concentrations under ambient conditions (in dry weather) to evaluate the potential impact of septic system failure. In addition, these are the periods when contact recreation is most likely to occur. Ambient monitoring should occur a minimum of four times annually, during both winter and summer, following a period of at least one week without rainfall.

2.2 Water Supply

Water supply for various beneficial uses (MUN, IND, AGR, PROC) is an important function of the Otay River watershed. An important element in preserving drinking water quality, especially in reservoirs, is the trophic status of the system, which is controlled by the input of nutrients. Eutrophic systems, characterized by a high level of biological activity, often exhibit algal blooms that can seriously impair drinking water quality. Septic systems located along the Upper Watershed may contribute a substantial nutrient (nitrogen and phosphorus) input to the creeks and then to the Upper and Lower Otay Reservoirs.

Reservoirs respond to changes in nutrient loads rather than to changes in concentrations. The load is the total mass of a constituent discharged and is calculated as the product of concentrations and volume of discharge. Consequently, monitoring for these constituents in the Upper Watersheds must occur where flow data are available for calculation of event mean concentrations in storms and total annual load. These data are currently collected only at the Jamul Creek USGS gauging station. The cost to include additional conventional constituents once a monitoring site and program are developed is small; consequently, it is recommended that a suite of water quality parameters be collected in addition to nutrient data. Samples should be collected during at least four storm events per year and four times under ambient conditions. The recommended list is presented in Table 1. This type of monitoring effort likely would cost on the order of $100,000 the first year when equipment is purchased and installed, and perhaps half of that for subsequent years.

Table 1 Recommended Constituents for Monitoring at Jamul Creek

Nitrate + Nitrite as N	Total Suspended Solids (TSS)
Total Kjeldahl Nitrogen (TKN)	Total Dissolved Solids (TDS)
Total Phosphorus	Dissolved Phosphorus
Total Zinc	Dissolved Zinc
Total Iron	Dissolved Iron
Total Copper	Dissolved Copper
Chemical Oxygen Demand (COD)	Total Coliform
Fecal Coliform	Enterococci

2.3 Habitat Protection

Regular bioassessments provide an integrated approach to assessing changes in the river ecosystem and water quality and provide a direct measurement of the degree to which the river supports the WARM beneficial use designation. Historical data are available for the Upper Watersheds and provide good benchmark information to determine whether changes in the aquatic ecosystem are occurring. A bioassessment should be conducted annually using the protocol applied in the previous studies by the San Diego Stream Team (*http://sdstreamteam.org/*), which is a citizen monitoring effort.

Table 2 presents a summary of these historical data, which will be useful as a benchmark (representing near 'natural' conditions) for comparison with downstream urbanized areas as such data become available. Table 3 provides a description of the metrics used in the historical data and their response to impairment. A bioassessment provides a measurable assessment of the long-term health of a stream by examination of the aquatic invertebrates that live in the water. Many insect taxa have aquatic larvae that inhabit a stream from several months to several years. Larval groups have differential tolerances to stream conditions including pollution. There are different feeding methods requiring certain conditions for obtaining food, anchoring in the substrate of the stream, etc.

Table 2 Bioassessment Data from the Otay River Watershed (Spring 2001)

Metrics	Dulzura Creek	Jamul Creek
Richness Measures		
Taxa Richness	6 *	5.3
Ephemeroptera Taxa	2	1
Plecoptera Taxa	0	0
Trichoptera Taxa	2	1
EPT Taxa	4	2
Composition Measures		
EPT Index	98	46.4
Sensitive EPT Index	1	0
% Hydropsychidae	92.9	24.8
% Baetidae	0	21.6
Tolerance/Intolerance		
Tolerance Value	4	5.2
% Intolerant Organisms	0	0
% Tolerant Organisms	0	3.1
% Dominant Taxa	92.9	43.9
Feeding Groups		
% Collectors (c)	5.1	55.1
% Filterers (f)	92.9	42.9
% Scrapers (g)	1	0.3
% Predators	1	1.7
% Shredders (s)	0	0

** Value based on average of three composite samples per site*

Bioassessments are considered an excellent way to measure the health of receiving waters. Rather than measuring concentrations of individual constituents and then assuming impairment exists, direct measurement of the biological health provides the ultimate answer as to whether conditions in the Otay River support a healthy biological community. In addition, bioassessments integrate the effects of all potential changes in the river due to changes in runoff volumes, runoff rates, and changes in the chemical and physical characteristics, including the synergistic effects of multiple pollutants. Consequently, a program of annual bioassessments in the Upper Watersheds could provide one of the better baseline indicators of the effectiveness of the BMP program.

Table 3 Bioassessment Metrics Used to Describe Benthic Populations in the San Diego Area

BMI Metric	Description	Response to Impairment
Richness Measures		
Taxa Richness	Total number of individual taxa	Decrease
EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	Decrease
Dipteran Taxa	Number of taxa in the insect order (Diptera," true flies")	Increase
Non-Insect Taxa	Number of non-insect taxa	Increase
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	Decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae with tolerance values between 0 and 3	Decrease
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	Decrease
Tolerance/Intolerance Measures		
Tolerance Value	Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) or intolerant (lower values)	Increase
Percent Dominant Taxa	Percent composition of the single most abundant taxon	Increase
Percent Hydropsychidae	Percent composition of the tolerant caddisfly family Hydropsychidae	Increase
Percent Baetidae	Percent composition of the tolerant mayfly family Baetidae	Increase
Percent Diptera	Percent composition of the tolerant insect order Diptera	Increase
Percent Non-Insects	Percent composition of the generally tolerant non-insect taxa	Increase
Percent Chironomidae	Percent composition of the tolerant dipteran family Chironomidae	Increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	Decrease
Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	Increase
Functional Feeding Groups (FFG)		
Percent Collectors	Percent of macrobenthos that collect or gather fine particulate matter	Increase
Percent Filterers	Percent of macrobenthos that filter fine particulate matter	Increase
Percent Grazers	Percent of macrobenthos that graze upon periphyton	Variable
Percent Predators	Percent of macrobenhtos that feed on other organisms	Variable
Percent Shredders	Percent of macrobenthos that screds coarse particulate matter	Decrease

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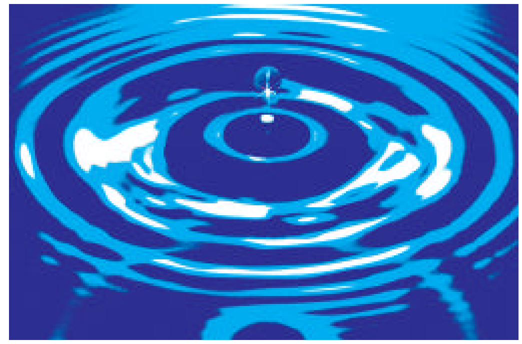


3 UPPER AND LOWER OTAY RESERVOIRS

Reservoir Monitoring Strategy: *Ambient water quality monitoring plan to determine whether land use changes, fires, or other factors will compromise the use of the reservoirs for recreation and as a source of drinking water.*

Water quality in the Otay Reservoirs may be threatened by a variety of sources. Substantial urbanization has occurred along the western shore of the Upper and Lower Otay Reservoirs. Stormwater runoff from these areas has the potential to convey sediment, nutrients, and other constituents to the lake. In addition, a large fire in the fall of 2003 exposed much of the area along the banks on the east side of the reservoirs to increased erosion. This erosion may substantially increase the turbidity, and convey large quantities of nutrients to the lake that might promote eutrophication. Finally, additional development in the Jamul and Dulzura watersheds that rely on septic systems can also increase the discharge of bacteria and nutrients to the reservoir.

This proposed monitoring strategy is designed to build upon existing drinking water protection monitoring programs. The City of San Diego has monitored the quality of water in Lower Otay Reservoir for many years, focusing on parameters related to its use as a drinking water source. This historical monitoring has consisted of hydrographic profiles (temperature, dissolved oxygen, conductivity, pH) and surface-water grab samples, the latter being analyzed for various suites of physicochemical constituents. Monitoring is confined to the vicinity of the WTP intake near Savage Dam, with sampling intervals of time ranging from weekly to semiannually (depending upon the importance of the parameter).

The present concern is the quality of the reservoir as an environmental resource, which introduces considerations that require expanded baseline data collection. The issues are the potential for hyperstimulation of productivity, increased turbidity, and, at a lower priority, introduction of organic pollutants. Hyperstimulation (popularly, eutrophication) is manifested by excessive blooms of phytoplankton and growth of stands of rooted aquatic plants (macrophytes). It is the result of increased loadings of nutrients, notably phosphorus and nitrogen compounds, due to both point and nonpoint pollution. Increased turbidity (diminished water clarity) can be either biological or physical in origin. The anticipated peripheral and watershed development of Upper and Lower Otay Reservoirs can entail increased sediment loadings and associated increased turbidity due to suspended matter. Algal blooms, associated with eutrophication, are the primary biological cause of increased turbidity.

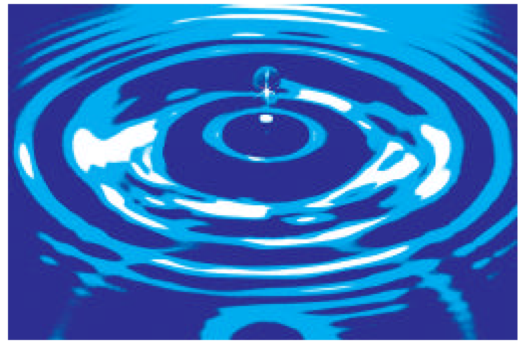
3.1 Enhanced Water Quality Monitoring of Otay Reservoirs

The necessary monitoring program has two strategic objectives: (1) characterize the hydrographic structure of the reservoirs; (2) characterize the biochemical quality of the reservoirs. "Hydrographic structure" includes the seasonal development and dissolution of stratification, as well as the response of the reservoirs to transient events such as storms and floods. With seasonal heat influx, the lake develops a two-layer structure, of which the upper aerated layer is most important for the biological functioning of the reservoir. The seasonal stratification is indicated by the thermocline depth and stability (both of which are quantified from vertical profiles of temperature in the reservoir). The "biochemical quality" of the reservoir refers to both the suite of chemical parameters that typically control biological processes, and the measures of biological response. "Characterize" includes delineation of the variation of the structure and biochemical measures in both space and time.

It will be necessary to perform profiling and water sampling at a series of stations distributed through the reservoirs. At the outset this should be approximately five stations on the mainstem (thalweg) of the Lower Otay reservoir from the dam to the upper reaches of the Jamul Creek arm, and one station in Upper Otay Reservoir. At each station vertical profiles of temperature, DO, conductivity and pH should be obtained with increased resolution (on the order of a meter) in the layers in which the variables undergo substantial changes (e.g., the thermocline layer). Water samples from the surface layer will be analyzed for nitrogen and phosphorus series, total suspended solids, chlorophyll-a, turbidity, coliforms, and enterococci. Sampling interval will be monthly around midday. As data are collected and analyzed, both the station distribution and the sampling interval will be adjusted as necessary, and over time, the suite of analytes will be revised to better reflect present and probable future conditions.

In addition to the mainstem stations, two stations should be occupied in coves along the shore(s) of maximal future development. Eutrophication is usually first manifested in the coves and inlets of a lake. These are the regions that receive direct storm runoff, and moreover, are shallow, relatively sheltered segments, so that nutrients may accumulate and stimulate the growth of flora. The presence of nuisance algae (evidenced by discolored, turbid water, and floating mats) or development of stands of macrophytes should be especially noted from field surveys, and may motivate station selection. As data collection progresses, it may be desirable to moor automated recording sondes, which monitor DO, temperature and conductivity, for several days in one of these inlets to determine the photosynthetic diurnal variation in oxygen.

It is assumed that the physical operation of the reservoir is adequately quantified, by routine recording of lake surface elevation, an accurate set of capacity-area-elevation relations, and relatively recent bathymetry, as well as historical data on pumpage, imports, diversions and spills, to enable a closing of the volume budget of the lake for at least a monthly time resolution. Any deficiencies in this sort of data should be repaired by the necessary measurements being incorporated into the baseline monitoring program.



4 LOWER WATERSHEDS

Lower Watershed Strategy: *Ambient and wet weather monitoring plan to document baseline conditions and trends associated with urbanization with an emphasis on potential impacts to the designated beneficial uses.*

Substantial urbanization has already occurred in portions of the Otay River watershed below the reservoirs, and additional changes in land use are expected in the coming years. This urbanization increases the volume and rate of stormwater runoff. This runoff may also be of lower quality than would occur in natural conditions. The effects of this urbanization will be seen in the tributaries and on a river system that has had 100 years to adapt to the hydrologic regime imposed by the dam.

In addition, approximately 20 leaking underground storage tanks (LUSTs) have been identified within the Lower Otay Watershed. Fortunately, almost all of these sites are currently undergoing site assessment or have remedial action already underway. Contaminated groundwater discharges could impact all of the designated uses of the Lower Otay Watershed. By inspection of the groundwater features near these underground storage tanks, it is clear that they pose a direct threat to the San Diego Formation Aquifer. If this contaminated groundwater were discharged into Otay streams as baseflow, there could be significant surface water quality impacts. Another threat to the lower basin is increased erosion of stream channels.

A particular important consequence of urbanization is channel instability, which impacts many beneficial uses and contributes to other identified problems. This problem is caused by natural channel change, development inside the watershed, increased flood flow peaks and/or volumes, and increased dry weather discharge and reduced sediment supply. Lowering of the channel invert, which historically would be interspersed with periods of channel aggradation (or infilling), turns into an increasingly destructive trend as the cyclical erosion and fill cycle has been replaced by continued degradation (general scour). Many of these impacts may be more prevalent in the tributaries such as Salt Canyon Creek, rather than in the main Otay River channel.

The majority of the sediment load from the upstream reaches of the Otay is deposited upstream of Savage Dam and is not allowed to continue into the lower reaches. This disruption of the natural aggradation/degradation process coupled with the slight erodability of soils in the lower basin combine to greatly increase channel erosion and incision. Monitoring of sediment transport rates in the lower reaches is critical to design controls for channel stabilization and rehabilitation. Sediment transport monitoring is also critical in this area because the area to the immediate east of Chula Vista is slated for development to >30% impervious cover. This increase in impervious cover will further reduce times of concentration and increase peak flows during storm events, hence the capability of storm hydrographs to erode the channel.

4.1 Habitat Protection

Protection of the beneficial uses associated with wildlife (WARM, WILD) requires preservation of the water quality in the system and the morphology of the existing channel and riparian corridor. The monitoring strategy to evaluate the water quality component should be based on the use of bioassessments.

4.1.1 Bioassessments

Regular bioassessments provide an integrated approach to assessing changes in the river ecosystem and water quality and provide a direct measurement of the degree to which the river supports the WARM beneficial use designation. Previously collected data upstream of the reservoirs (Table 2) can provide good benchmark information for comparison with the data collected in the Lower Otay Watershed. A bioassessment should be conducted annually using the protocol applied in the previous studies by the San Diego Stream Team (*http://sdstreamteam.org/*) to facilitate comparison with historical data.

At this stage of planning, it is difficult to delineate specifics of a bioassessment monitoring program. Station selection should be based upon representativeness of the combination of morphology and plant life, proximity to potential future development areas, and historical bioassessment surveys. Most important is building up a series of bioassessment surveys over time at established locations. While new stations can be added in the future in response to changes in the watershed, this should be in addition to, and not at the expense of, established bioassessment stations. While an annual survey interval is generally satisfactory for long-term monitoring, it is important that the surveys be performed in that part of the year in which ecosystem communities and hydrometeorology are stable in time, normally around June of each year.

4.1.2 Channel Stability Assessments on Salt Creek

The second monitoring element is the assessment of channel stability. Changes in the rate of erosion can have dire and costly consequences for urban infrastructure installed in or adjacent to stream channels and impair RARE and WILD beneficial uses. Salt Creek is particularly susceptible to these problems because of the degree of urbanization expected in its watershed.

Urbanization has already eliminated much of the riparian habitat in the lower Otay River watersheds, and threatens those along Salt Creek. Figure 2 summarizes the relative hydrologic integrity of riparian reaches on the Otay River watershed. Smith (2004) assigned a Hydrologic Integrity Index score to 212 riparian reaches on the Otay River watershed in order to measure the change in the hydrologic characteristics (e.g., frequency, magnitude, and temporal distribution of stream discharge, baseflow, and flood patterns) relative to historical hydrologic characteristics of culturally-unmodified riparian ecosystems in the region.

Because of the scarcity of data for the Otay River watershed, the Hydrologic Integrity Index was tied to two types of characteristics: (1) those that influence on the frequency, magnitude, and temporal distribution of stream discharge; and (2) characteristics that influence the hydrologic interaction between the stream channel, floodplain, and historical terraces. The Hydrologic Integrity Index thus provides an indirect estimate of deviation from reference condition based on changes in specific characteristics and processes of a drainage basin such as interception, infiltration, evapotranspiration, percolation, groundwater flow, and surface water flow overland and in channels.

Salt Creek runs north to south along the western side of the Otay Reservoir. The headwaters of Salt Creek are located near Mother Miguel Mountain. There are several small water reservoirs near the foot of the mountain and the Auld Golf Course. The upper part of the Salt Creek watershed is undergoing significant urbanization, with major road crossings with culverts at Proctor Valley Road, Otay Lakes Road/Wueste Road, and Olympic Parkway. Hunte Parkway generally runs parallel, but offset by several hundred feet, on the west side of the creek between Proctor Valley and Otay Lakes Road. Salt Creek Road is an unimproved road that runs parallel on the east side creek below Olympic Parkway, much closer to the drainage course. The Salt Creek watershed below Olympic Parkway is generally open-space preserve, but there are two underground aqueducts that transect the watershed on their way to the Otay Water Treatment Plan. Salt Creek confluences with the Otay River just upstream of the planned State Route 125 crossing.

Consequently, a program to characterize changes in channel morphology is recommended for Salt Creek. This program will assess the effectiveness of stormwater BMPs implemented in the new developments and determine whether they are successfully preventing downstream impacts. One method to characterize the stream morphology is the Rosgen system. The Rosgen system exploits the fact that streams tend to organize themselves around the most likely combination of variables based on physical and chemical laws. This tendency to seek a dynamic equilibrium reflecting landscape conditions in a watershed lends itself nicely to classification. The Rosgen classification system assessment should be completed for selected stream reaches in Salt Creek every two years to track changes to the stream cross-section and profile. This assessment should include reaches downstream of Olympic Parkway as well as one or two upstream reaches that are surrounded by development.

4.1.3 Stream Gauging on Otay Main Stem at I-5

Changes in river and stream morphology are generally related to changes in the volume and rate of runoff and sediment supply. Implementation of BMPs may reduce these changes, but it would be difficult to quantify without better data on current and future river discharges. Consequently, a permanent station to monitor river discharge rates is warranted in the lower part of the watershed.

The establishment of a river gauging station on the main stem of the Otay River near its mouth would also provide useful information for assessing the impact of urbanization and other land use changes. It would also allow evaluation of the degree of perennialization of the streams in the watershed. A location near the crossing of I-5 would integrate the changes in runoff volume and rate. In addition, the station could also be used to establish a water quality monitoring site should one be desired in the future.

4.2 Recreation

The Lower Watersheds of the Otay River have recreational designated beneficial uses (REC1 and REC2). In addition, the river discharges to San Diego Bay, which also has recreational uses. These uses in the watershed may be impaired by the changes in channel configuration described above or by reduction in water quality.

4.2.1 Water Quality Monitoring on Otay River Main Stem

The primary water quality concern is that increases in bacteria concentrations in dry weather flows may adversely affect designated REC1 and REC2 beneficial uses. Consequently, monitoring should include:

- fecal coliform
- total coliform
- enterococci

These various indicator organisms were chosen to provide a comparison with historical data from this area and to assess compliance with objectives that are now being adopted for beaches and waterways in the San Diego area.

Bacteria may increase in baseflow from sewer overflows, pet wastes, the homeless, and other sources. These are conveyed to the river by stormwater runoff or non-storm discharges resulting from excess irrigation, car washing, or other activities that generate dry weather flows.

Bacteria concentrations are commonly high in stormwater runoff, even in relatively undeveloped watersheds. Consequently, it is important to also characterize bacteria concentrations under ambient conditions (in dry weather) to evaluate the potential impact of leaking sewer lines, septic system failure, and other sources of bacteria on water quality. In addition, these are the periods when contact recreation is most likely to occur. Ambient monitoring should occur a minimum of four times annually, during both winter and summer, following a period of at least one week without rainfall.

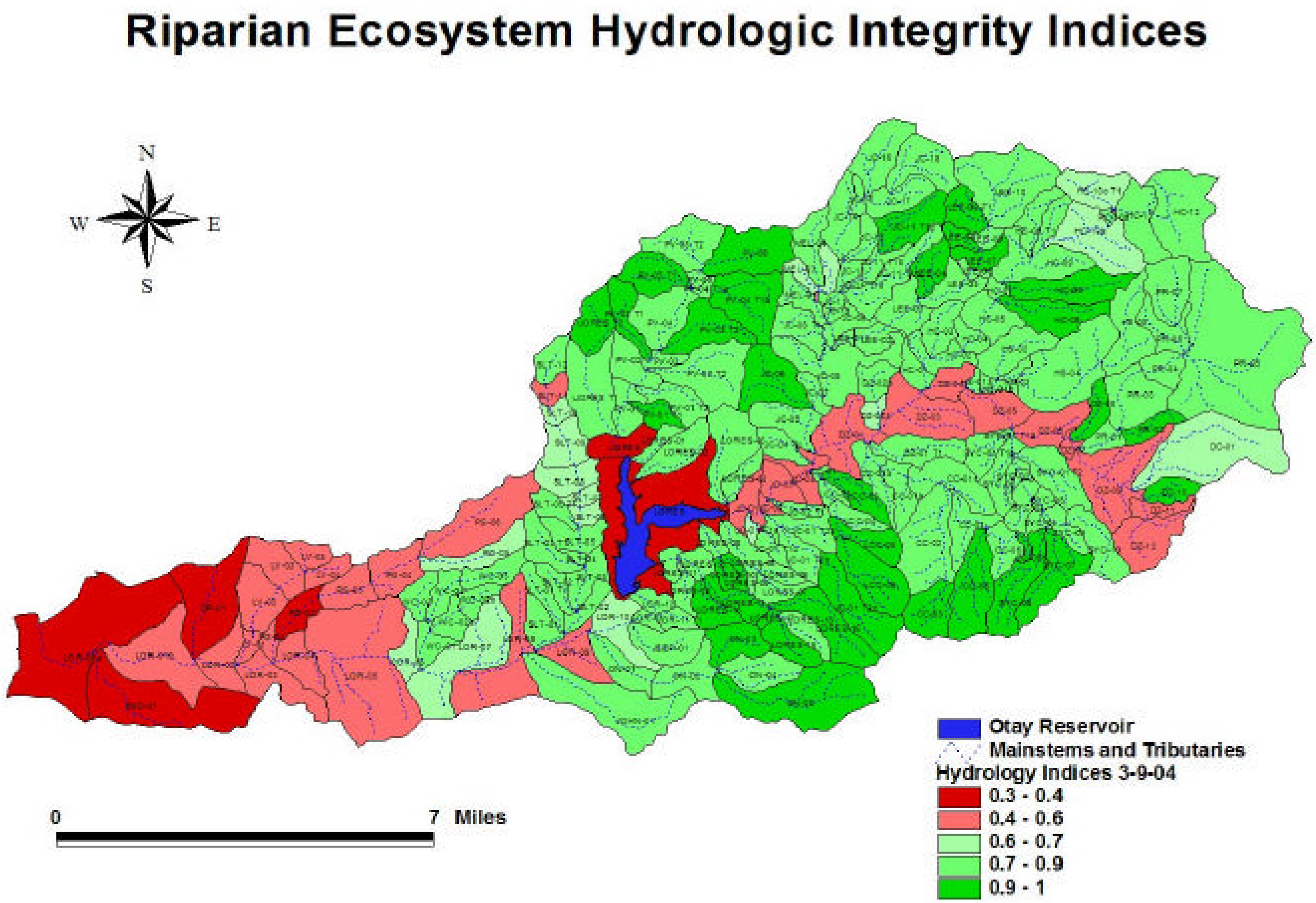


Figure 2 Hydrologic Integrity Indices for Riparian Reaches Extrapolated to Local Drainages (Smith, 2004)

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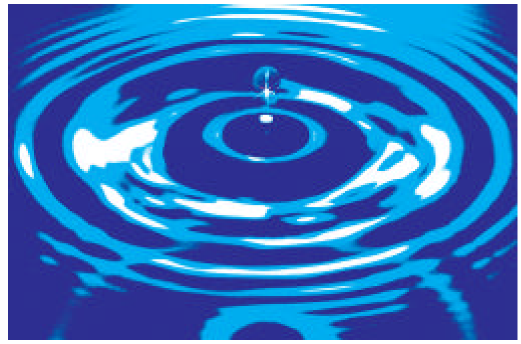

5 MONITORING STRATEGY SUMMARY

The water quality monitoring strategy for the Otay River watershed establishes a basis for a long-term monitoring program for the watersheds and reservoirs to establish baseline conditions, identify trends in degradation, isolate sources of contamination, and determine effects of management practices. Figure 3 summarizes the water quality monitoring strategy for the Otay River watershed.

Upper Watersheds. Ambient and wet weather monitoring plan to document baseline conditions and trends with an emphasis on potential changes associated with the widespread use of septic systems in the watershed. The strategy is to install a permanent water quality monitoring station at the USGS Jamul Creek gauging station to monitor loads of nutrients and bacteria discharged to the Upper Otay Reservoir. This will be supplemented with ambient monitoring focused on characterizing concentrations of indicator organisms under baseflow conditions.

Reservoirs. Ambient water quality monitoring plan to determine whether land use changes, fires, or other factors will compromise the use of the reservoirs for recreation and as a source of drinking water. The monitoring effort has two strategic objectives: (1) characterize the hydrographic structure of the reservoirs; (2) characterize the biochemical quality of the reservoirs. These will be addressed by establishing a series of profile and water sampling station along the centerline of the reservoir and in selected coves or inlets.

Lower Watersheds. Ambient and wet weather monitoring plan to document baseline conditions and trends associated urbanization with an emphasis on potential impacts to the designated beneficial uses. This effort has multiple objectives. The first objective is to document changes in channel stability from stormwater runoff associated with urbanization, which is the product of the channel stability assessments. The second objective is to quantify current and future concentrations of bacteria that impact recreational uses in the river and bay through a dry weather monitoring program. Finally, the monitoring effort will provide the data for an assessment of urbanization on the water balance for the watershed through establishment of a stream gauging station near the mouth of the river.

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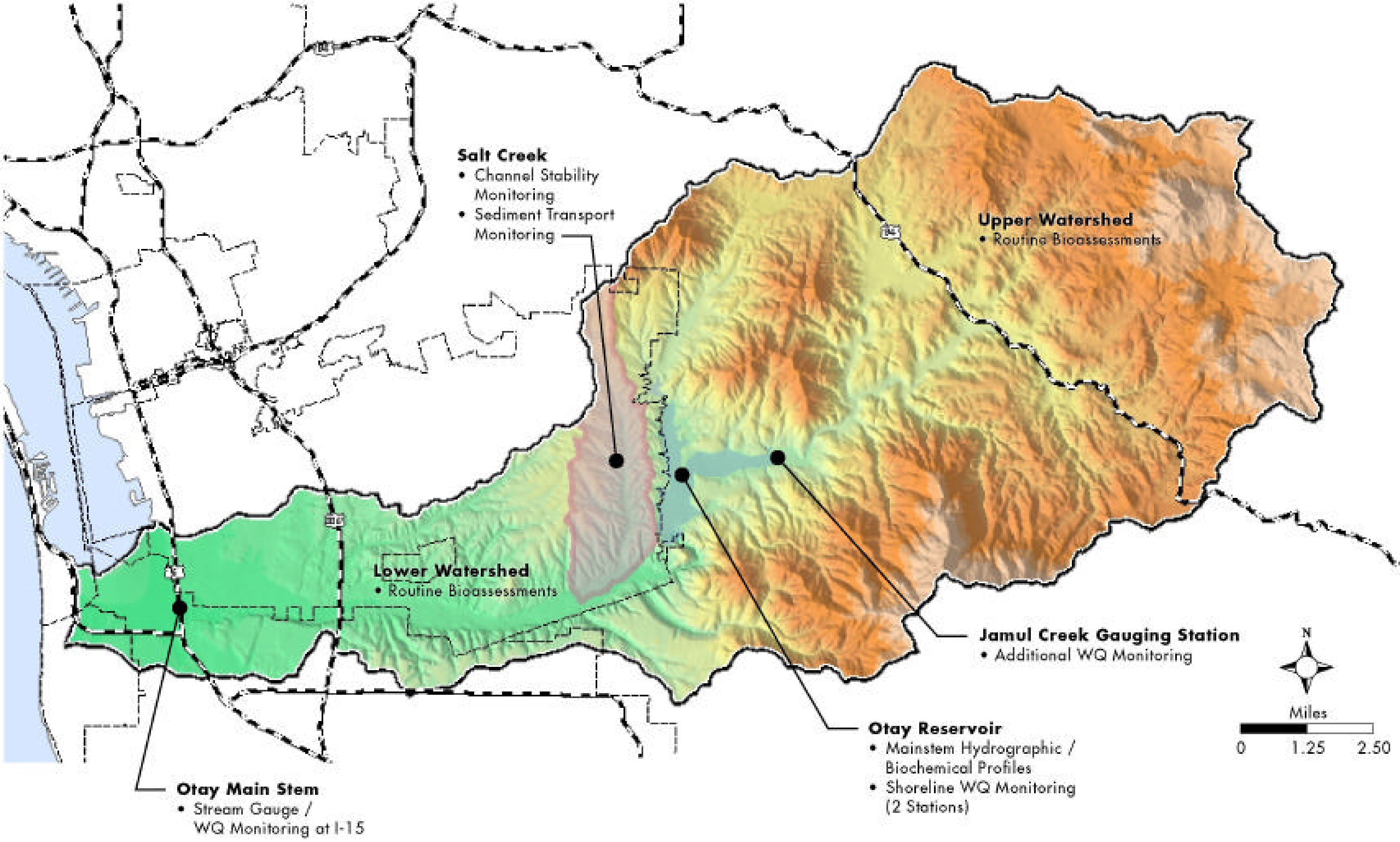

Figure 3 Water Quality Monitoring Strategy for the Otay River Watershed

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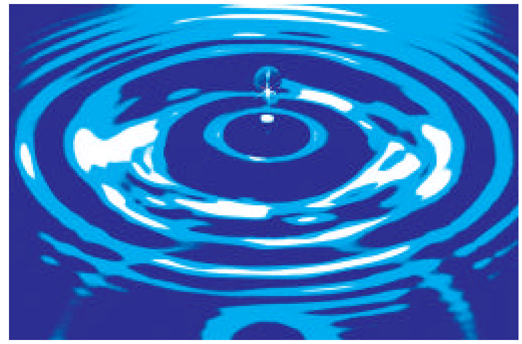

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